BROOKHAVEN NATIONAL LABORATORY

BNL Role in US ATLAS

U.S. ATLAS

Construction/Installation

Commissioning/ATLAS Upgrade

David Lissauer

DOE Annual HEP Review

Brookhaven National Lab

April 27, 2005

BROOKHAVEN NATIONAL LABORATORY

BNL's Role in ATLAS

U.S. ATLAS

- **Overview of BNL Role in ATLAS** — H. Gordon
  - Physics & Analysis Center
  - BNL Role US ATLAS Management
- **Construction/Installation/Commissioning/ ATLAS Upgrade** — D. Lissauer
  - Construction:
    - Liquid argon calorimeter
    - Cathode strip chambers for the Muon system
  - Installation & Commissioning
    - ATLAS Technical coordination
    - LAr, Muons
  - ATLAS upgrade – Tracking/Calorimeter/Muons
- **Software and Computing** — S. Rajagopalan
  - Tier I Center
  - Core Software
  - Subsystem Specific
  - Analysis

General Approach

- Construction responsibility matched to unique technical capability at BNL.
- Physics & Instrumentation Division were pioneers in R&D for both LAr calorimeter and cathode strip chambers.
- Contribution to the analysis builds on the detector expertise in the calorimeter and muon systems.
- Main effort in ATLAS upgrade will concentrate on the tracking system. BNL taking an active role with unique developments.

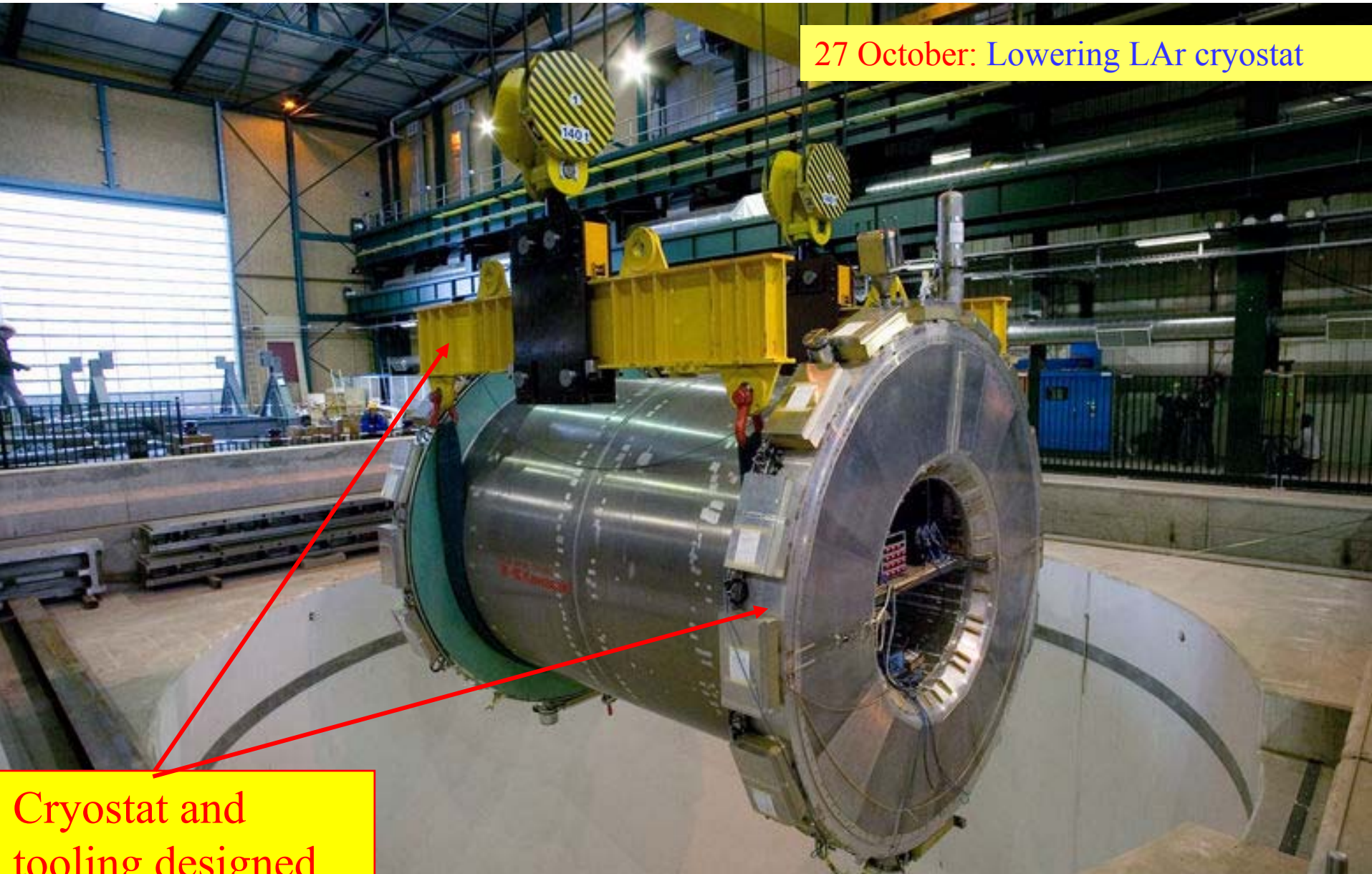
Cryostat & Feedthroughs

- **Barrel cryostat** — **J. Sondericker, *D. Lissauer***
- **Feedthroughs** — **T. Muller, *B. Hackenburg***

- Production started March '99 at KHI. Arrived at CERN and accepted by ATLAS by Aug '01.
- Feedthrough production factory and test facility set up at BNL.
- All 64 FTs (100K Channels!) installed and fully checked in March '02.
- EM Calorimeter installed in the Cryostat in '03 and Cold vessel was welded shut by end of '03.
- Solenoid installed the Cryostat Vacuum in early '04.
- Cool down on surface April '04 cold test completed by Sept '04.
- Transport & Installation in Experimental Hall October '04.

- Move to final position August '05. (Limited by Toroid Installation Schedule)
- Cool down end of '05.

Barrel Cal. Surface



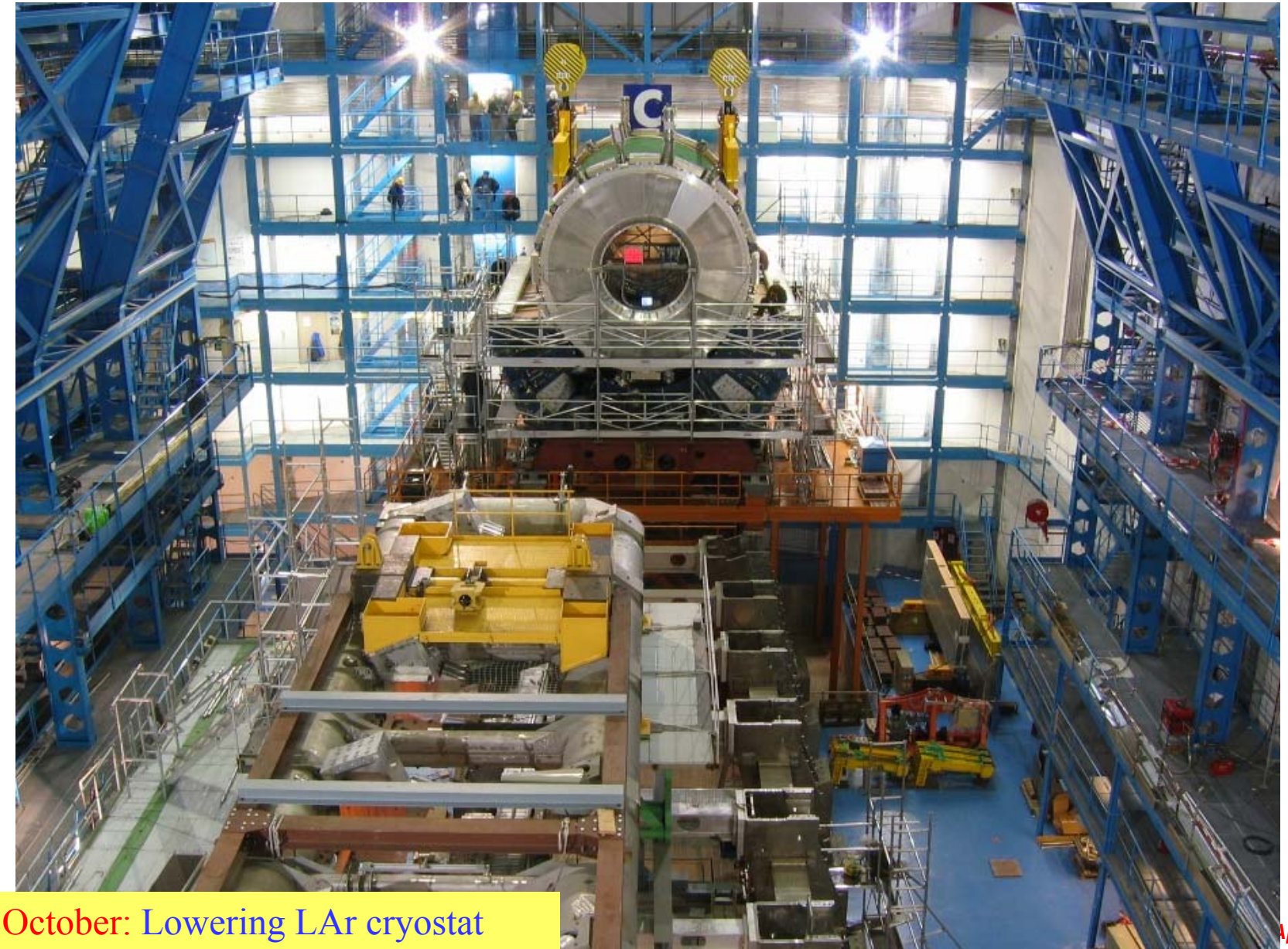
In the Shaft

27 October: Lowering LAr cryostat

Down 100 meter shaft…

Position to 2 mm in X/Y.

Alignment on Tile



27 October: Lowering LAr cryostat

Barrel Cal. Complete

10 Dec. 2004: Barrel assembly Completed.

LAr Cryogenics

- **Responsibility:** J. Sondericker , D. Lissauer
  Refrigerator, LN_2 ,Dewar, Quality Meters, Control System
- Contract Air Liquide for: Refrigerator , Nitrogen Dewar
  - All Components installed and accepted at CERN.
  - Significant effort by Cryogenics team in the last year.
- Quality Meter (Built at BNL)
  - Installed at CERN.
- Control system
  - Functional analysis and programming for N_2 control.
- System acceptance tests
  - Completed March '05.
- First cool down of Calorimeter in the Pit '05.

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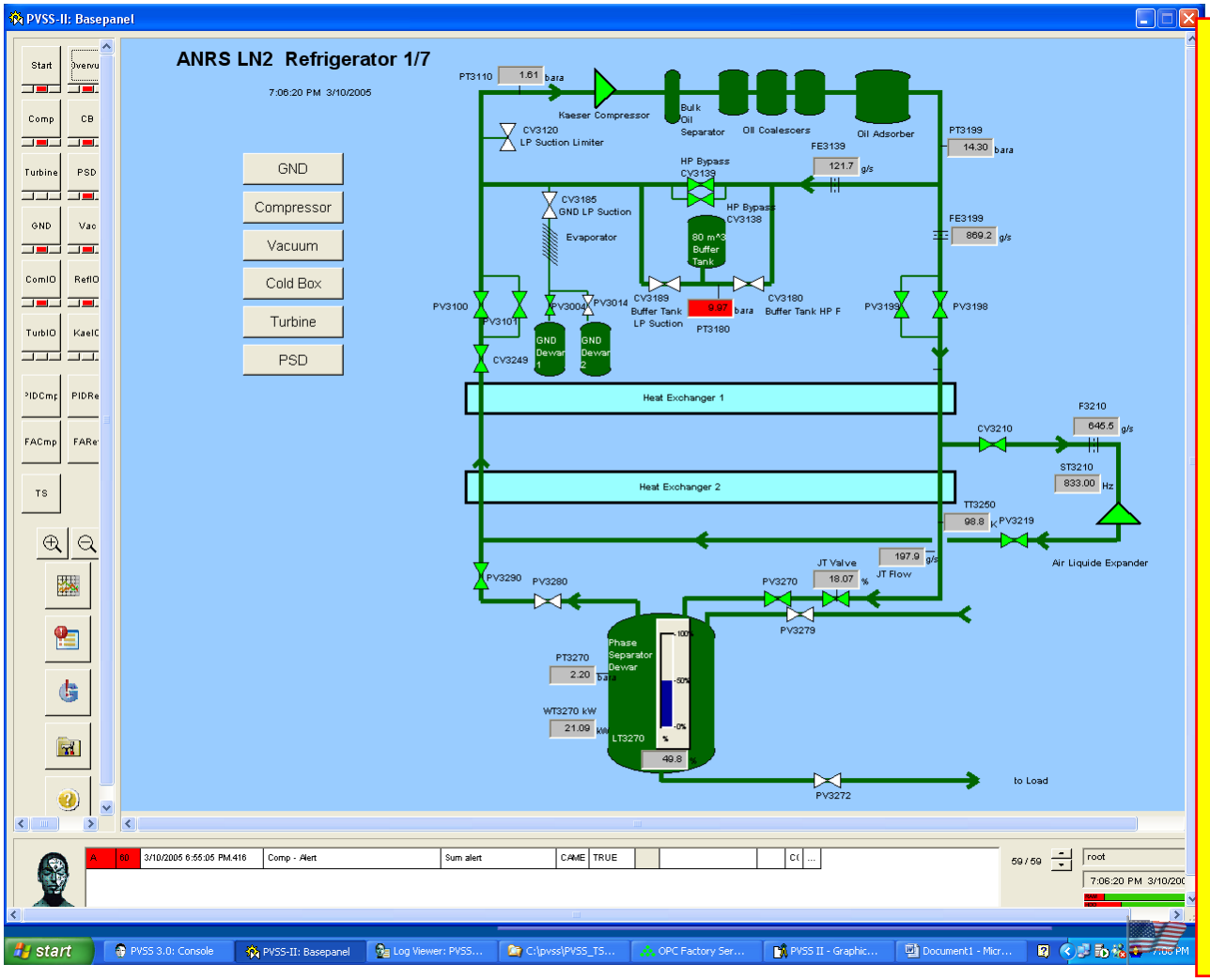
LN_2 Dewar Installation

U.S. ATLAS

Very tight Installation @ CERN

Cryogenics Commissioning



Refrigerator has been accepted at CERN by ATLAS.

Next steps:

Commissioning of the full system including the Cryostat.

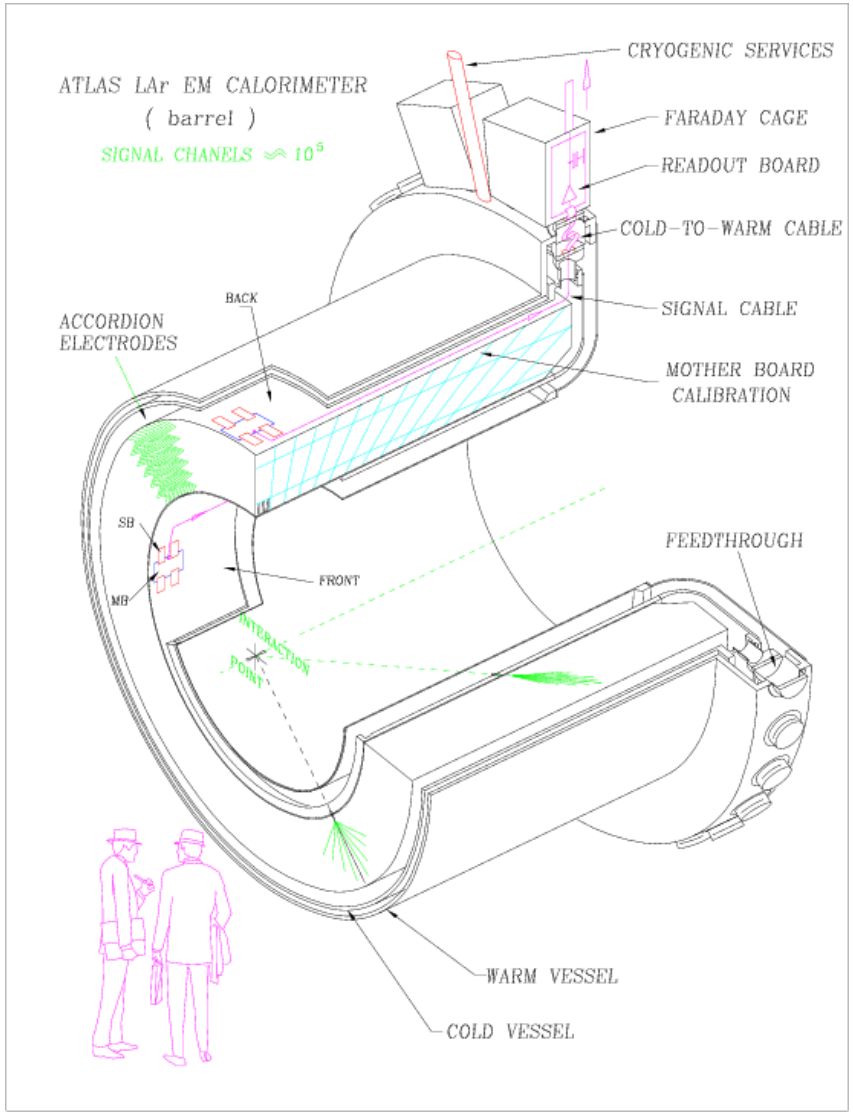
Cool down end of '05.

Online Refrigerator Control

LAr Readout Electronics

- Electrodes *
- Motherboards* (cold elec.)
- System crate: on detector electronics
  - Preamps**
  - Monitoring Board**
  - Warm cables*
  - Base-plane – analog trigger sums.*
  - Pedestal and Crate*
  - Cooling system
  - FEB Final Assembly and testing
  - Rad-hard power supply
- System Tests
- Installation/Commission of front-end electronics

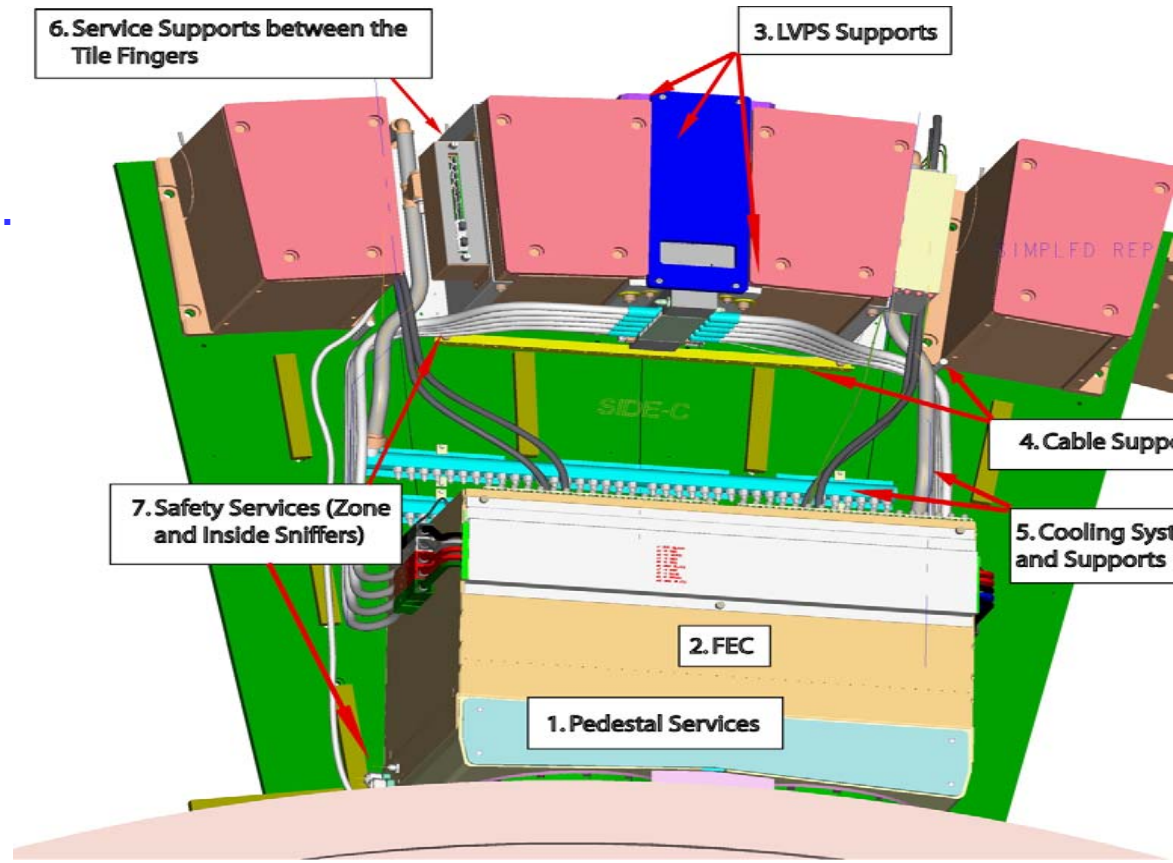
- * Production Completed and Installed
- ** Production completed waiting for installation.



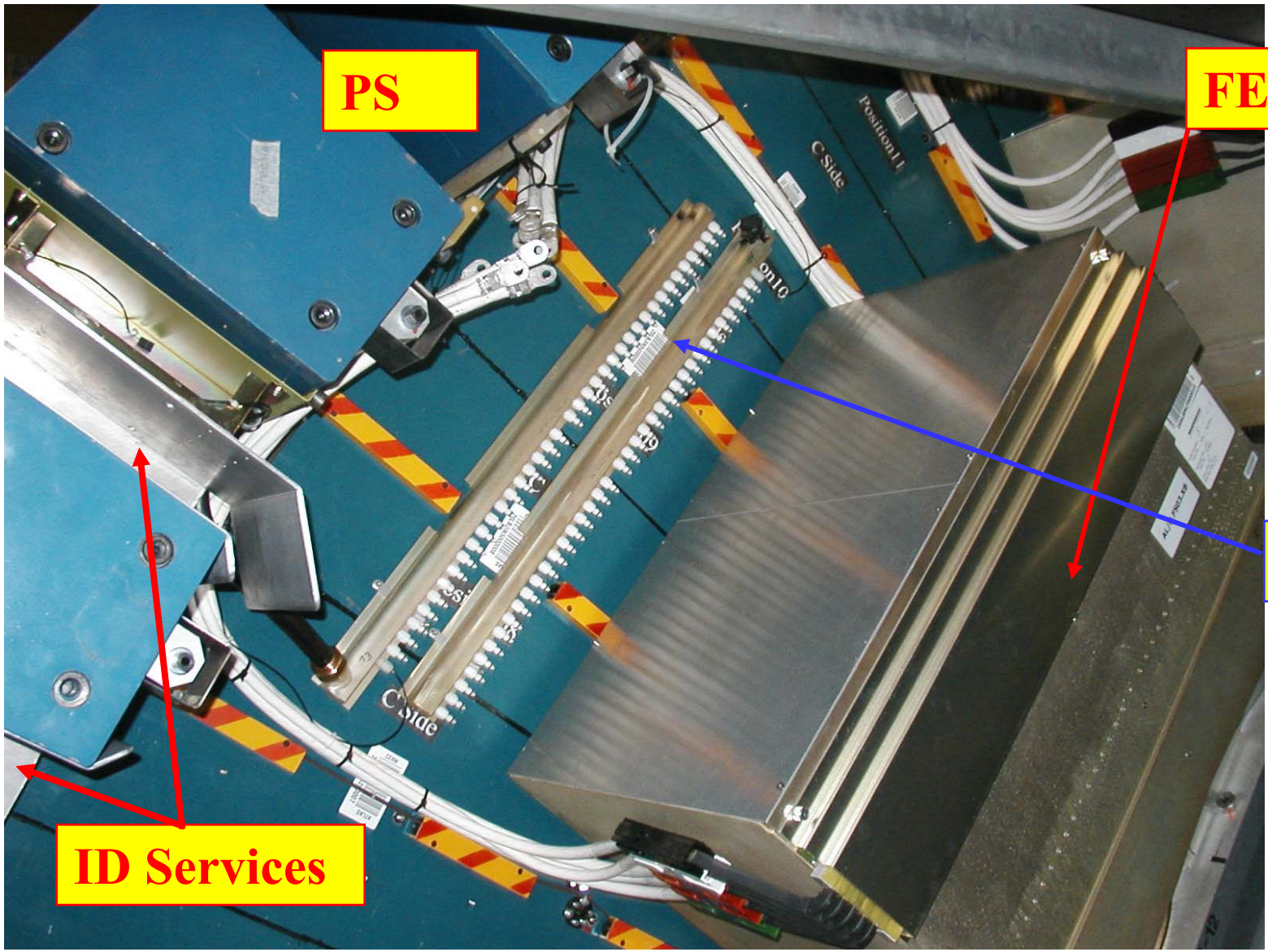
Crate Assembly & Integration

- **Persons Responsible:** F. Lanni, T. Muller and S. Norton
- **Institutions:** BNL (Barrel) , Milano (EC)
- **Responsibility:** Barrel & EC electronics crates

- **Warm cables, Pedestal and Base-planes**
  - Production & Installation completed.
- **System Crates.**
  - Production Completed.
    Installation Barrel Completed.
    EC Installation end of ’05.
- **Cooling System**
  - Production 80% Completed.
- **Crate Monitoring Board**
  - Production Completed.
  - Installation end of ‘05
- **Integration in Experiment.**
  - Design and interaction with Technical Coordination to define all interfaces.
    Barrel well advanced ,
    EC in progress.



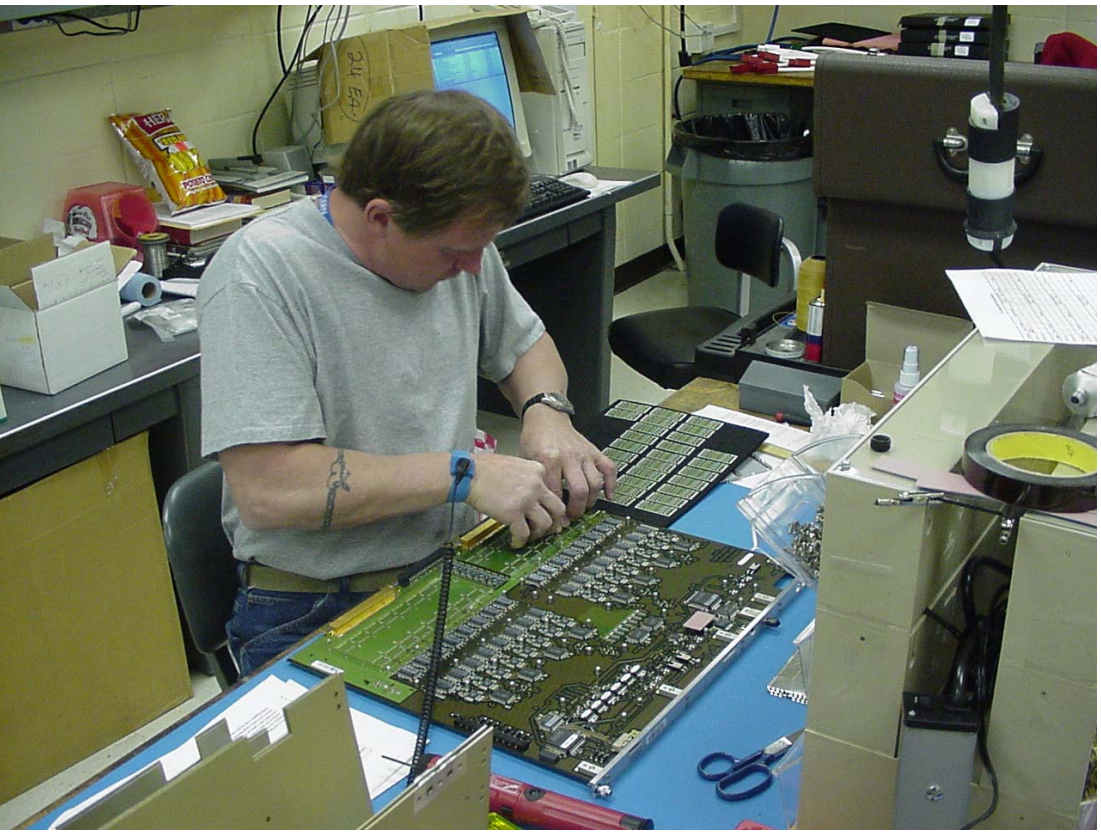
The Real Thing



“The A team” (BNL technicians) installation in the Pitt.

FEB Assembly & Testing

- **BNL involvement in the FEB started in the design stage – design and production of analog front end.**



Assembly of Analog Part.

Cooling installation

Testing of boards (using the system test setup)

Production started.

Expect to finish before the end of the year.

Power Supply

- **Persons Responsible:** F. Lanni, J. Kierstead (Eng.)
- **Institutions:** BNL
- **Responsibility:** All LAr Front End Power Supplies.

- **3.2 kW Power**
- **Radiation Levels of 50 KRads.**
- **Critical Space Limitations.**
- **High Reliability (N+1 Design)**

Open PS.

16x30x30 cm

- **Development and tests Completed in '03/'04.**
  - Radiation tests completed on components
  - Gamma, proton, and neutron radiation with less than 1% variation observed
  - Production prototype finished by end 2003
- **Contract signed with MDI April '04.**
- **First Articles delivered – reliability problems found at BNL. Identified as damaged capacitors.**
- **Production resumed now – with modified assembly procedure**

Front-End System Test

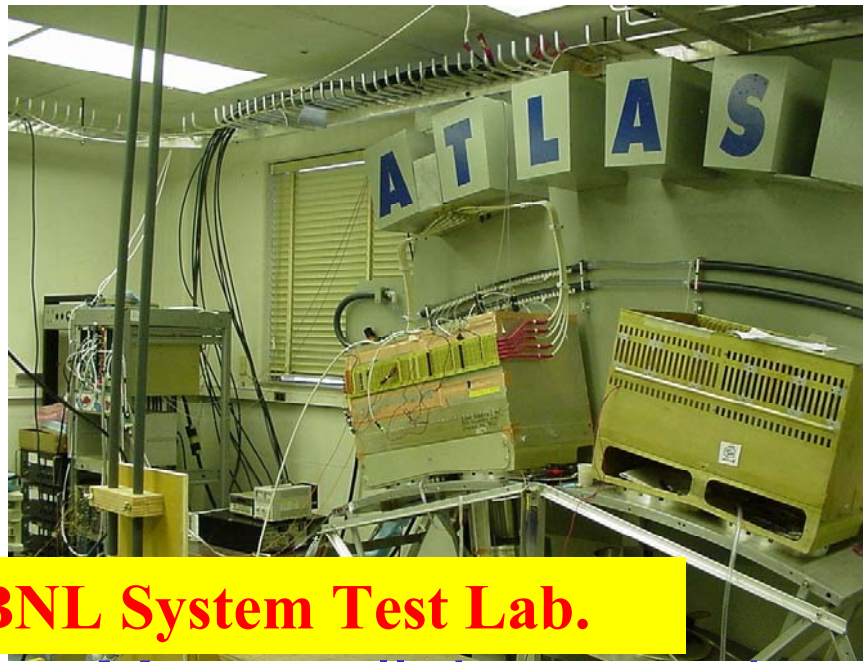
- **Person responsible:** **F. Lanni, H. Chen; S. Rescia, D. Makowiecki (Eng.)**
- **Institutions:** **BNL**
- **Responsibility:** **Full front-end electronics system integration**

- F. Lanni is the LAr Front-End Electronics Coordinator

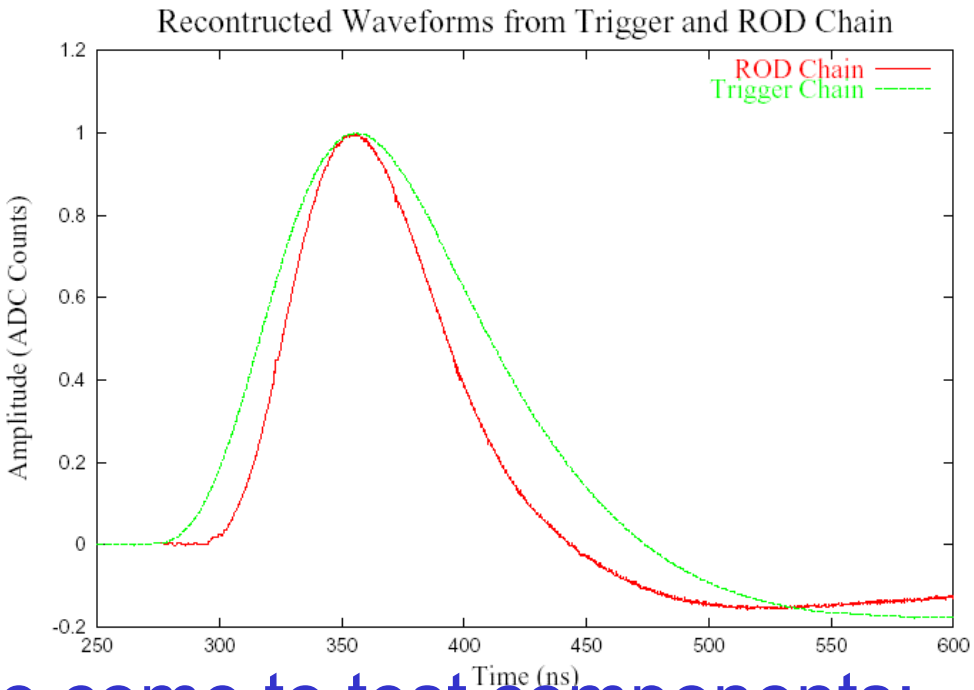
- FEC system test system at BNL:
  - Unique in ATLAS for LAr Calorimeter
  - Integration of power supply, cooling, ROD, DAQ, analysis and people
  - Test for dynamic range, linearity, coherent noise, crosstalk.
  - Preparation for FEB production tests.

- System validation of FEC for All components
  - EM-Barrel, EM-Endcap, Hadron Cal, Forward CAL
  - Prove system performance
  - Debug installation procedures
  - Identify possible critical points.

System Tests



BNL System Test Lab.



- Many collaborators have come to test components:
  - Annecy, Orsay, Saclay, Paris VI, Pittsburgh, Stony Brook, Nevis
- Full system has been completed.
- Online software integration
- **Long term stability tests ongoing.**

LAr Next Steps

- Effort shifting to installation and commissioning.
- Cryogenics:
  - System commissioning in ’05 – ’06.
- Barrel Cryostat:
  - Move to Z=0 (final Position) August ’05.
  - In Situ cool down early ’06.
- Electronics:
  - Electronics installation in the pit in ’05-’06
- Commissioning:
  - Using Calibration system start end of ’05.
  - Using Cosmic Rays – full readout system ’06.

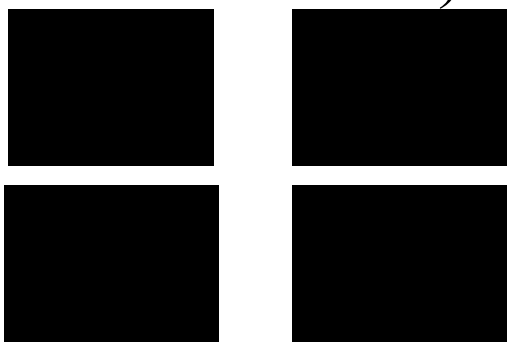
CSC Status

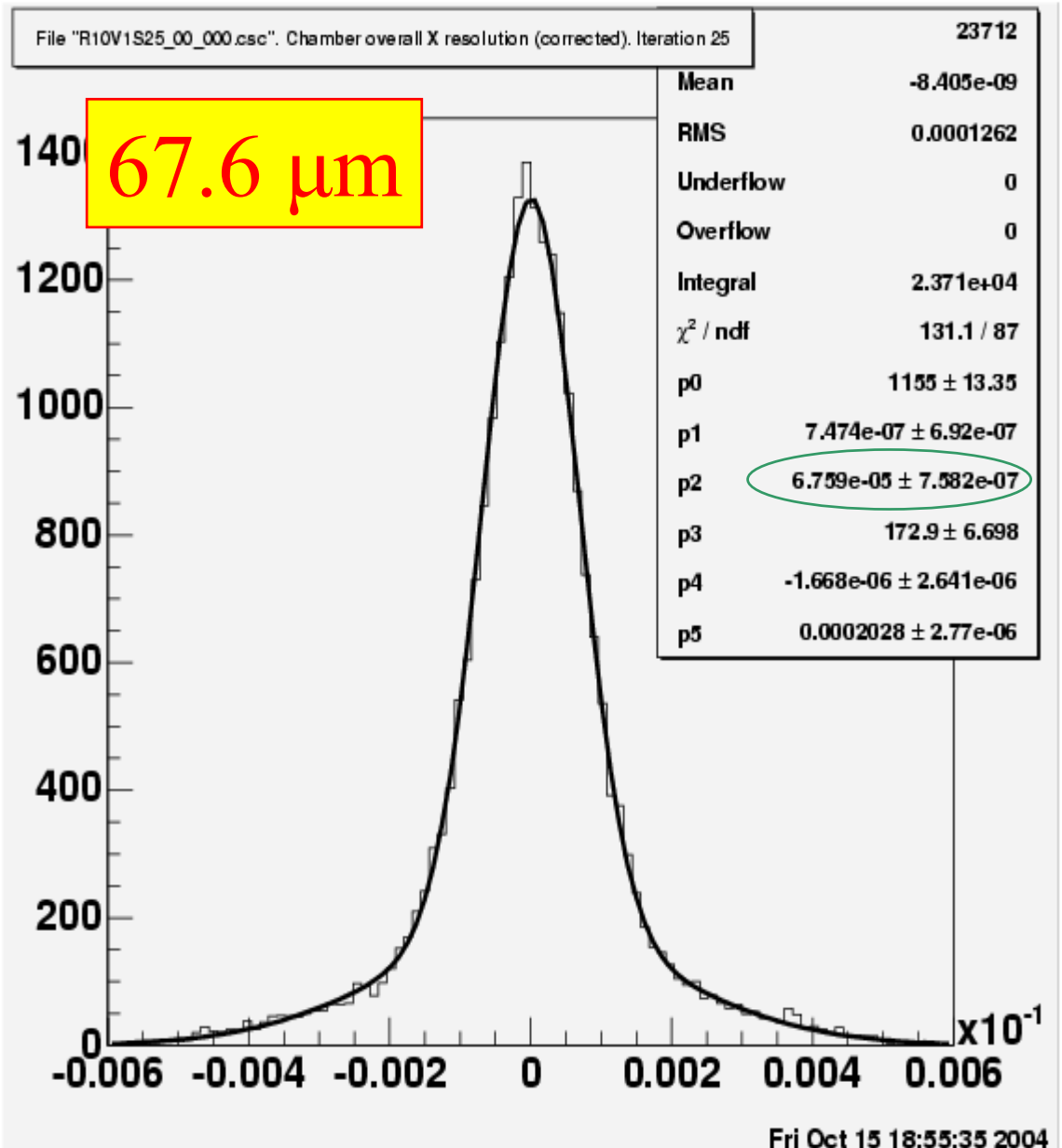
- Chamber construction completed more than a year ago
- Front end electronics produced, undergoing detailed tests
- Remaining components for chamber integration being assembled; integration to start mid-May and expected to take ~2months
- Fully integrated and tested chamber to be shipped to CERN at the end of this year
- CSC scheduled installation about a year from now
- Off-chamber electronics are under construction at UC Irvine with compatible schedule

CSC Chambers Waiting for final integration.

CSC Resolution Test beam Results

Residuals of all planes filled with the following factors (corrections on correlations between track parameters and plane measurements):





Technical Coordination

D. Lissauer* , A. Gordeev, S. Norton, R. Ruggerio

*TC Activity A (Project Office) Manager

*ATLAS Technical Management Board

*Coordinator US ATLAS TC: (Arizona, BNL, ANL, LBNL and Boston)

Configuration Control

Placement in situ

Services Routing

Access during installation & operation

Pix of the Experimental Hall April 22, 2005.

4th coil move to final position.

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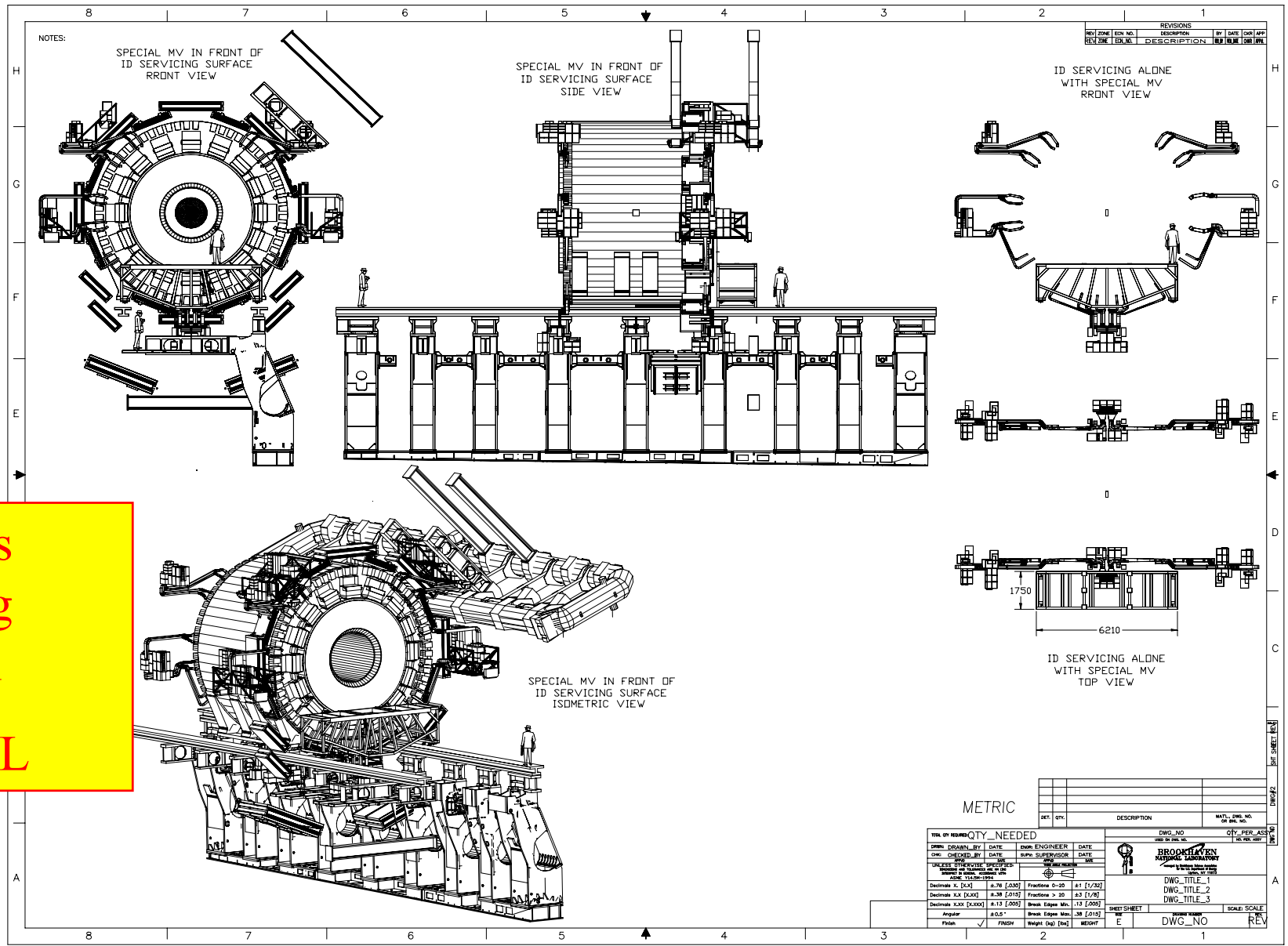
U.S. ATLAS

Access to the Cal.



Access tooling design @ BNL

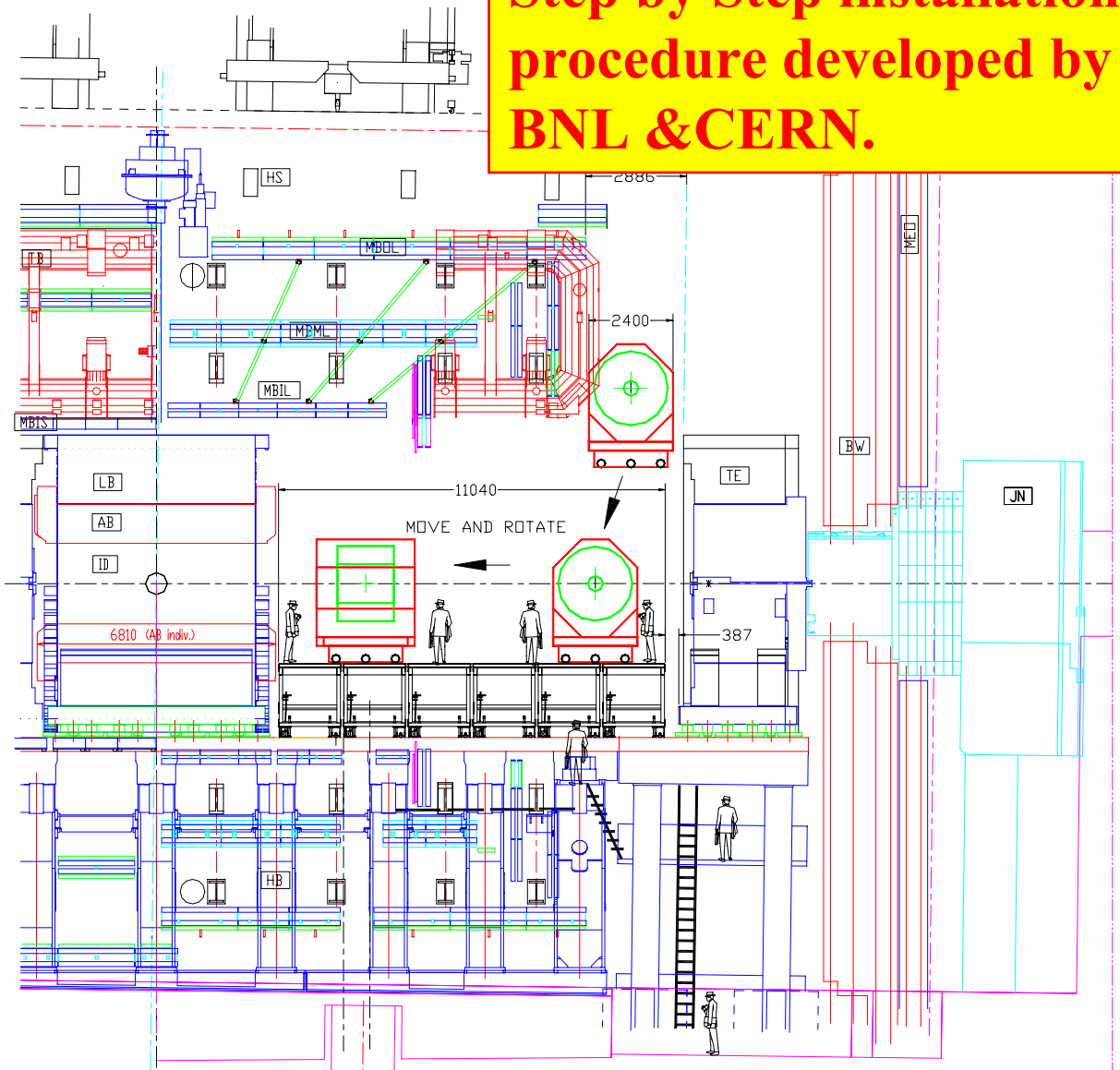
ID Wheels Installation Procedure

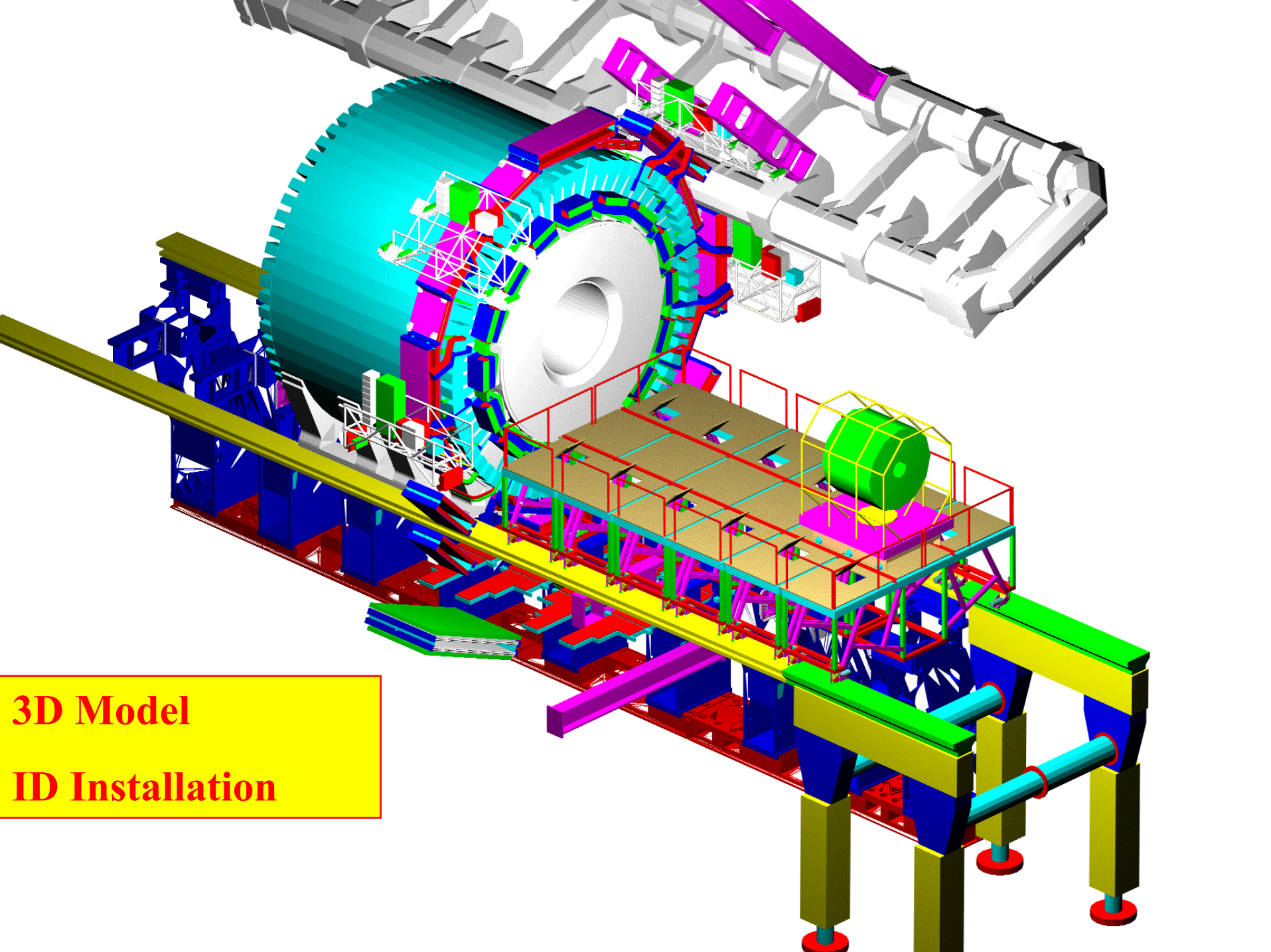
Step by Step installation procedure developed by BNL &CERN.

- 6 MV JOINT TOGETHER CREAT CONTINIOUS PLATFORM FROM CRANE ACCESS POINT TO LAr CALORIMETER BORE. (SIDE C AND LATER SIDE A)

- TROLLY RAILS FOR WHEELS (ID) INSTALLATION USED ON SIDE C AND LATER ON SIDE A.

- AT THIS TIME THE BARREL ID IS ALREADY INSTALLED SO ACESS FROM SIDE A (OR C)



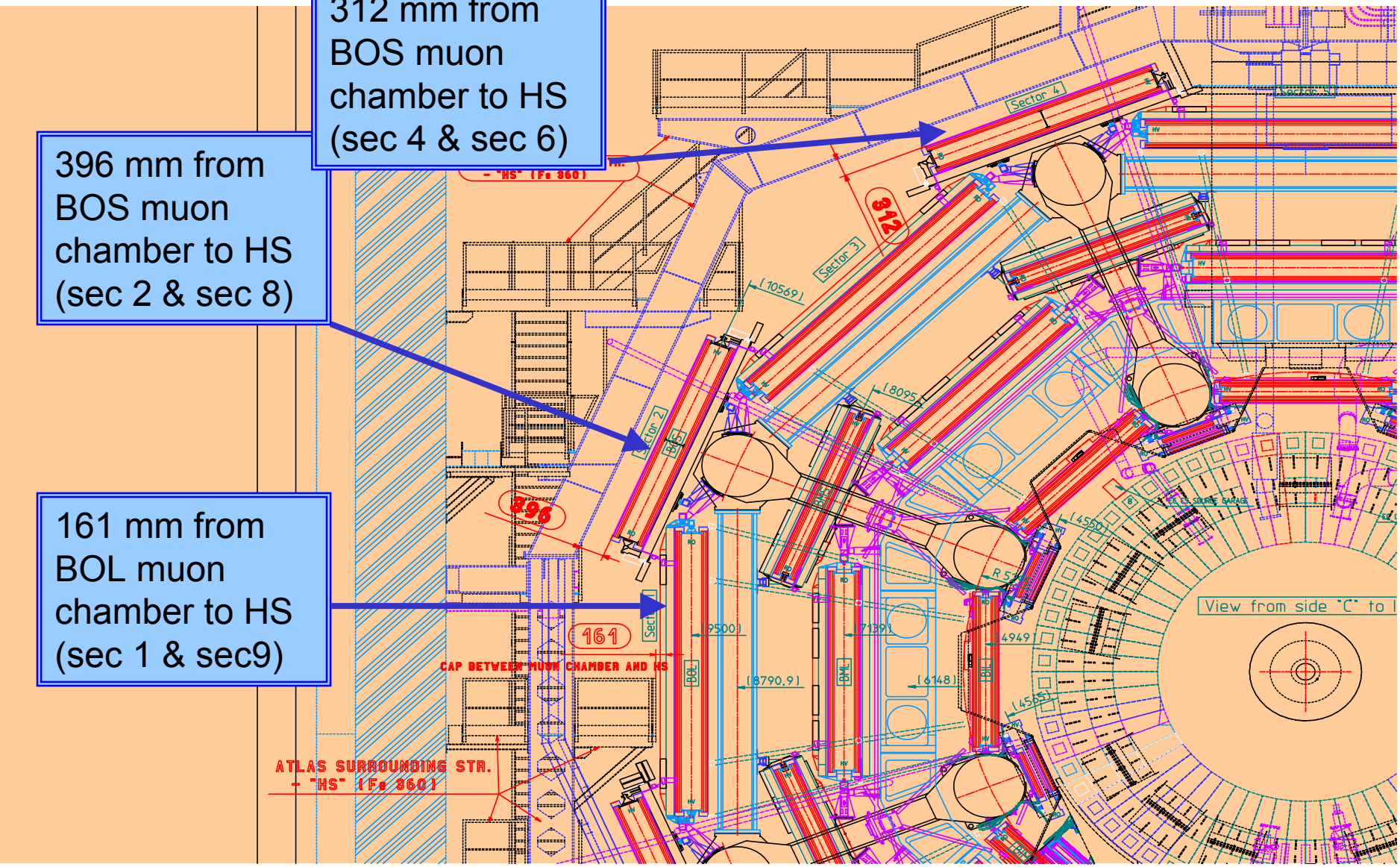

3D Model
ID Installation

Magnetic Field Calculations – I. Stumer (BNL)

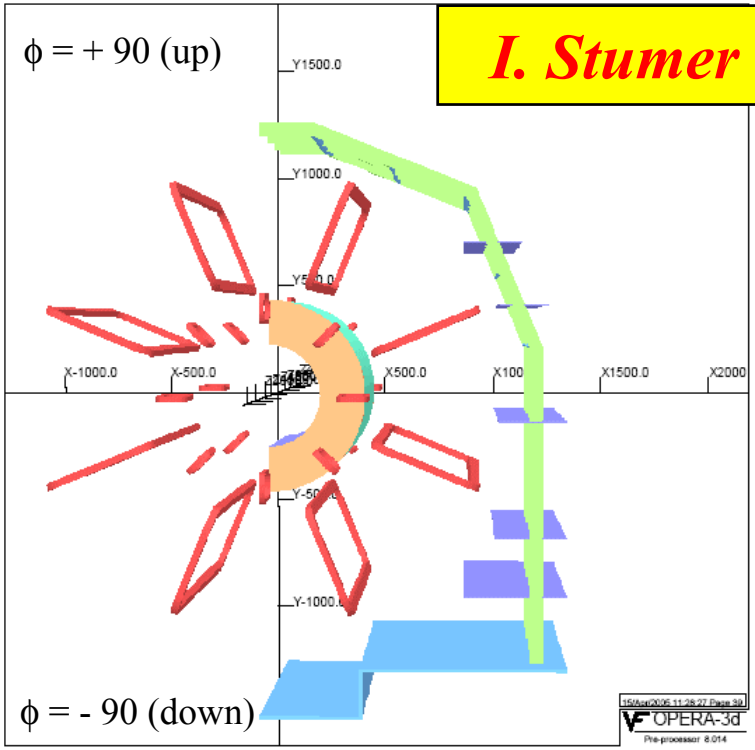
312 mm from BOS muon chamber to HS (sec 4 & sec 6)

396 mm from BOS muon chamber to HS (sec 2 & sec 8)

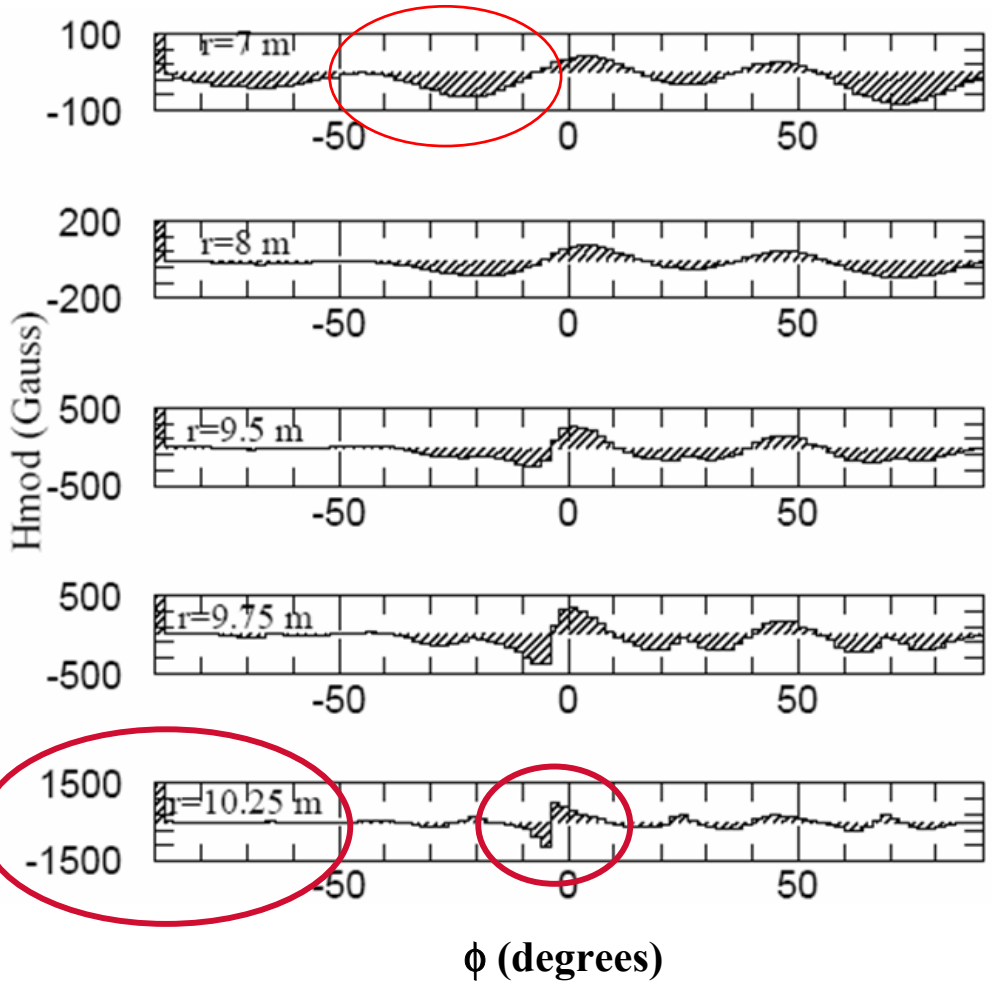
161 mm from BOL muon chamber to HS (sec 1 & sec9)



I. Stumer (BNL) [updated 19 Apr 05]



Δ|H| = (coils+HS) – (coils only) @ z=0



Conclusions (so far..)

- the HS structure effects range from 50 to 1000 Gauss when radius is increased from 7 to 10 meters.
- At least part of the discrepancy wrt early estimates is associated with better modeling of platforms & poles
- But several issues in this simulation remain to be clarified/understood
- ➔ PRELIMINARY !

LHC upgrade

- Consider LHC Luminosity upgrade
  - SLHC : $L = 10^{35}$ /cm^2 /s
  - Bunch crossing: 25ns → 12.5ns
  - No. interactions/Crossing: 20→100
  - Radiation: X10
  - Rates: X10
- US Representation in ATLAS Upgrade steering group.
  - F. Lanni LAr Calorimeter upgrade
  - D. Lissauer TC / integration
  - A. Seiden (Santa Cruz) ID Upgrade

Inner Tracker

- D. Lynn, D. Lissauer, P. Nevski (Physics)
- Z. Li, P. O'Connor, V. Radeka (Inst. Div.)

Development of Single Sided
2D detectors.

Cost Effective Large Area Detectors.

Material Studies: High Radiation levels needed for LHC.

Geometrical Configuration: Optimization of granularity and shape.

Industrial Production: Establish contracts with Si manufacturers.

In Collaboration with:
Santa Cruz
LBNL
Hampton University

Calorimeter R&D

- F. Lanni, H. Chen, D. Lissauer (Physics)
- S. Rescia, P. O'Connor, J. Kierstead ,V. Radeka (Inst. Div.)

Readout System Architecture

SiGe Front end (Preamp, Shaper, T&H)

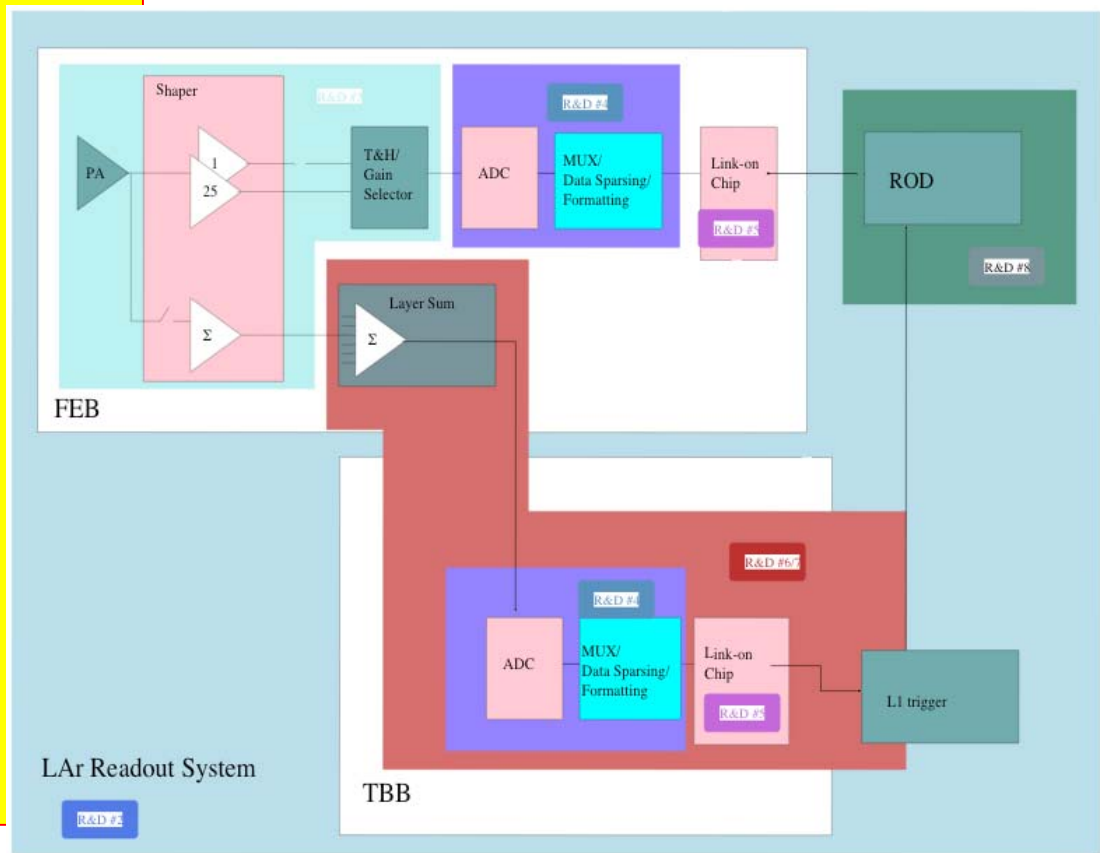
Radiation Hard Power Supplies

ROD – Read out Drivers.

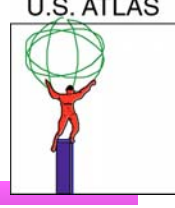
Interface to Level I

In Collaboration with:

Columbia Univ. (Nevis)
Stony brook
Pittsburgh
SMU



Summary



- Detector construction at BNL is being completed. All major construction to be completed by end of '05. ON COST/SCHEDULE
- Present effort concentrate on Installation and commissioning, including efforts in the Subsystems as well as in Technical Coordination. BNL leads the U.S. effort.
- LHC upgrade R&D is underway. BNL has major involvement in a new ATLAS tracker and upgrade to the present calorimeter readout. Plans for forward muon systems. (Construction expected to start in ~ 4 years from now)
- These efforts compliment well and are coordinated with the ongoing physics analysis efforts.